TECHNICAL NOTES.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

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SOARING FLIGHT IN GUINEA.

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Translated from the French ,
By D. L. Bacon, Assistant Physicist,
Aerodynamical Laboratory, N.A.C.A.,
Langley Field, Va.

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In the Notes published in the Reports of October 20th and December 8th, 1913, I described the first part of our work on soaring flight. This work, interrupted by the war, was renewed in the latter part of 1919, thanks to an appropriation from the Service des Inventions.

The term soaring is here applied to the flight of certain large birds which manoeuver in the air without moving their wings. Many theories have been evolved and published relative to this mode of flight. (See Cousin, Lanchester, Hankin, etc.) Of all these theories the only ones acceptable are those based on the utilization by the bird of the internal energy of the wind. In the particular cases studied in the above mentioned Notes the energy required for the support was supplied by an upward component of the wind.**

It seemed doubtful whether this is always the case, particularly so in the case of certain African plains, above which

* Presented before the Academy of Sciences by M. Deslandres, February 2, 1920.

**Other forms of internal energy may be supplied by varying or turbulent air flow. (Translator.)

birds soar continually and over considerable distances. (See the famous observations by Mouillard in "L'Empire de l'Air.")

New methods have been devised for studying the irregularities of the wind and the horizontal and vertical components of its velocity in those regions where the birds are flying. For this purpose we used the Service des Inventions anemometer kites which permit measurement of the speed and irregularities of the wind by means of a force indicator whose readings may be controlled by various means. Also, for the study of the vertical component, we used kites which carried a pivoted arm, the angle between which and the vertical was a function of the angle of the wind with the horizontal. This angle was determined from the ground by the use of a Rochon telescope and trigonometric calculations. This enabled us, knowing the velocity of the wind, to determine its vertical or horizontal components.

We also used, with some modifications, the sounding balloon method described in the above mentioned Notes. The balloon was adjusted to have a low ascensional velocity and a Rochon telescope was used instead of a camera in order to investigate conditions at greater distances and altitude. A complete study of the sources of error introduced by this method justified its use.

These different experimental methods permitted us to make aerodynamic investigations in the zones of operation of the soaring birds. We worked particularly in the vicinity of Dakar and in Guinea.

1. In these regions the wind nearly always has a vertical component, and, if this vertical component were plotted over a

horizontal plane at a definite height from the ground positive areas (ascending currents) and negative areas (descending currents) would be noticed. Some of these areas remain fixed in position (being caused by natural obstacles) and the other areas move without apparent laws and due to undetermined causes.

2. The regions of soaring flight always coincided with the areas of ascending air. It is in these areas that the birds fly, either circling or following an irregular course. The birds move with moving areas of rising air and do not cross from one positive area to another except in approximately straight lines and without stopping. They might thus lose a little altitude with impunity which they would regain in the next positive area; this would at first sight give the impression that they sailed at random throughout the atmosphere.

3. We were unable to establish any connection between irregularities in the wind and soaring, soarability often occurring in a feeble and regular breeze.

These prime facts having been once established and the upward component of the wind ascertained to be the cause of soaring flight it is obviously possible, by repeated experiments, to determine the minimum upward component necessary to support the soaring bird. If, in addition, the absolute speed of the bird be determined trigonometrically, the velocity of the wind being known, the speed $\underline{V}$ of the bird relative to the air might easily be figured. From this we might deduce the lift/drag ratio which, as is easily seen is equal to v/V where $\underline{V}$ is the vertical component of the wind velocity. The lift, moreover, is equal to the weight P of the bird.

If the lifting surface A is also known the coefficients Ky and Kx may be determined from the formulas

$$\text{Lift} = K_y A V^2$$

$$\text{Drag} = K_x A V^2$$

and various birds may be compared from the standpoint of their aerodynamic efficiency.

By this method the following approximate figures were derived. We hope to check them by more numerous and exact measurements and to include later all types of soaring birds.

Bird	V Relative Air Speed m/sec.	v Upward Air Velocity m/sec.	L/D	K_p $Kg/m.^2$ m/sec.	K_p Kg/m^2 m/sec.
Egyptian Vulture	7.5	0.5	15	0.06	0.004
African White backed Vulture	8.5	0.5	17.5	0.12	0.007

Bird	V Relative Air Speed ft/sec.	v Air Velocity ft/sec.	L/D	K_y lbs/sq.ft. mi/hr.	K_x lbs/sq.ft. mi/hr.
Egyptian Vulture	24	1.6	15	.0025	.00016
African White backed Vulture	28	1.6	17.5	.0049	.00029

These figures however are taken from a very limited series of observations and we publish them only as a first approximation which we hope to confirm by continued research. Nevertheless they have thrown some light on the use by birds of the internal energy of

the air, and, if not on the only form of soaring flight, at least on one of them, for we could not state without pursuing a new set of experiments that other birds have not other means of utilizing the internal energy of the air. Of particular interest in this connection is the albatross, which we hope soon to study, and whose flight over the Southern seas evokes the admiration of those travelers and scientists who have had the opportunity to see it.